

DENT

ON THE

AZIMUTH AND STEERING  
COMPASS.

PUBLISHED BY THE AUTHOR,

82, STRAND; 33, COCKSPUR-STREET; AND 34, ROYAL EXCHANGE, LONDON.

MDCCCXLIV.



7881

A PAPER,  
ON THE  
PATENT AZIMUTH AND STEERING  
COMPASS,



EDWARD J. DENT, F.R.A.S. Assoc. I.C.E.

HONORARY MEMBER OF THE UNITED SERVICE INSTITUTION ;

BY SPECIAL APPOINTMENT

CHRONOMETER AND CLOCK MAKER TO HER MAJESTY THE QUEEN, AND HIS ROYAL HIGHNESS  
PRINCE ALBERT.

---

PRESENTED TO THE MEETING OF THE BRITISH ASSOCIATION  
FOR THE ADVANCEMENT OF SCIENCE, AT YORK.

---

*Read, 30th September, 1844.*

PUBLISHED BY THE AUTHOR,  
82, STRAND ; 33, COCKSPUR-STREET ; AND 34, ROYAL EXCHANGE, LONDON.

MDCCCXLIV.



LONDON:  
BRADBURY AND EVANS, PRINTERS, WHITEFRIARS.

A PAPER, BY E. J. DENT,

ON HIS

PATENT AZIMUTH AND STEERING  
COMPASS.

---

I BEG permission to state, that as the specification of the patent does not come due until January next, and not having as yet given any publication relative to improvements in Compasses, the subject of this communication may be considered original.

Regarding the mechanism of the Instrument, perhaps the Section will not expect that I shall enter fully into exact details upon the subject, under existing circumstances; but I may be allowed to state, that there does not appear to me to be any obstacle in effecting the improvements contemplated; and that a Steering or Binnacle Compass has already been completed for trial, which is now on board H.M.S. *Blazer*, with the sanction of the Admiralty.

Amongst the evils arising from the present construction of Compasses, we may observe the following:—1st. The friction arising from the imperfect mode of suspension; which is well known to be that of a hollow cup in the centre of the Needle, resting upon a steel point; in which case it is obvious that a want of horizontality in the card

(which, from a circumstance that I shall mention, must unavoidably occur,) will cause considerable friction between the convex sides of the pivot and the sides of the cup. 2dly. A considerable error is caused by the assumption, that the *Magnetic Axis* of the Needle coincides with what is called the *Maker's Axis*, which is the line determined by the marks or zero points on the extremities of the Needle ; which error in flat needles, such as are usually applied to Compass-cards, is frequently of such magnitude as to be quite inadmissible, even in Compasses for common purposes, much less for those intended for accurate experiment. 3dly. Another source of inconvenience and inaccuracy arises from the unequal amount of inertia as regards the axis, or horizontal line drawn through the centre of the card, about which line it is compelled to vibrate or deviate from its horizontal position by means of the alternate pitching and rolling of the vessel. To explain this, suppose a vessel steering N. or S. by compass, a pitching motion would in this case cause the card to move about a line drawn through the E. and W. points, and this arises from the circumstance of the gymbal apparatus in which the card is suspended not completing its vibration in the same time as the card does in its vibrations above and below the horizontal plane ; which difference in the time of vibration of each, causes the convex sides of the pin upon which the card turns to come in contact with the sides of the cup in which it moves, and thereby communicates a vibratory motion to the card. From the position of the Needle with respect to the axis referred to, it is plain that the distance of the centre of gyration, and consequently the time of vibration about that axis, is a maximum.

Again, in a rolling motion (that is, about the axis of the vessel,) the vessel's head being in the same direction, the card from the same cause will in this case vibrate about an

axis drawn through the N. and S. points of the card ; and the time of its vibration is then a minimum.

In any other motion of the vessel, the corresponding motion of the card is compounded of these two effects, which produces the “waddling” or undulatory motion observed when the motion of the vessel is considerable and irregular ; and the cause of which, I believe, has not been previously assigned. However well, therefore, the gymbal apparatus, in which the card is placed, is balanced, yet as the card has a motion or time of vibration peculiar to itself, depending upon the position of the axis of its vertical vibrations with respect to the axis of the Needle— which vibrations are not altogether under the control of the gymbals although its vibrations are continually checked, and its quiescence disturbed by it in consequence of the supporting pin coming in contact with the sides of the cup, as before mentioned—yet in the present construction of the Binnacle Compass, the card ever will be subject to irregular deviations from the horizontal plane, arising from this cause.

The mode by which (I trust) I have removed these evils has been, by altering the nature of the suspension ; that is, by suspending the card in a similar way to the balance of a Chronometer, and with equal delicacy, both ends of the pivot acting on diamonds, and the holes jewelled, by which means the card is constrained to move very nearly in the horizontal plane, since in this respect it is entirely under the control of the gymbals. The friction is also considerably reduced by this mode of suspension. The great accuracy with which the card returns to the same position has been clearly shown by a great number of experiments ; and I am not aware of any mode which offers so severe a test in the present case, as the agreement between consecutive observations. To

remove the error arising from the non-agreement of the *marked* or *maker's* with the *magnetic axis*, a simple contrivance is effected for the *inversion of the card*, so that either side of it may be placed *above* or *below*. Since the marked axis of the Needle is in each of these positions at equal distances from, but on opposite sides of the magnetic meridian, a mean of an equal number of observations in both positions of the card will evidently eliminate any error of this nature, and give the true magnetic azimuth of the observed object, *at the time of observation*, by an equal compensation of error. It is also plain that the constant adjustment required to make a delicate needle horizontal in different magnetic latitudes is rendered thus unnecessary.

There can be no doubt that the want of the principle of *inversion* in Azimuth Compasses has most materially vitiated every result hitherto made to determine the variation of the Needle in different parts of the world; and I consider the usual construction of these instruments to be very discreditable, in the present state of mechanical science. Those persons who have been accustomed to the instruments known by the name of Kater's or Schmalcalder's Azimuth Compasses, which were considered more accurate than any that had been previously made, are well aware of the constant attention they require to render them horizontal in different parts of the world; and they must doubtless have seen marked upon them what is called their "index errors," which are to be applied to the observed azimuths; in some amounting to two or three degrees, and more. How such "index errors" were determined has not been explained, and perhaps it would be useless to inquire. In all probability it was done by observing, with the different Compasses, the azimuth of a fixed mark, the *true* magnetic azimuth of which was *presumed* to be known; by which mode every consideration of secular or diurnal



change in the position of the Needle is dispensed with, and the method of course subject to error, which can only be removed by *inversion*, and without which no instrument of the kind can have any claim to accuracy.

I trust, by the mode of construction by which I have proposed to remedy the existing evils in Compasses, a very superior Common Binnacle or Steering Compass will be introduced; and another instrument also, for the united purposes of an Azimuth or Surveying Compass and Dipping Needles, having great facility of manipulation, and with every refinement as regards workmanship and quality of the Needles, at a much less price than either of these instruments can be procured for, as they are usually constructed.

ED. J. DENT.

82, STRAND,

28th September, 1844.

Digitized by the Internet Archive  
in 2018 with funding from  
Wellcome Library

<https://archive.org/details/b30366306>

A PAPER  
ON  
THE SHAPE OF THE WHEEL-TEETH  
IN  
The Clock for the New Royal Exchange.

PRESENTED TO THE MEETING OF THE BRITISH ASSOCIATION AT YORK

*Read 30th September, 1844.*

---

BY EDWARD J. DENT.

---

IT will perhaps be generally admitted, that the geometrical form of the wheel-teeth in Chronometers, Watches, and Clocks, is but seldom or ever attended to by the persons who either cut the wheels or make the pinions; and it may be explained from the circumstance of these operations being separated into two distinct trades. The system pursued by workmen to insure what they suppose to be the proper form of the wheel-teeth, is, that it should, as nearly as possible, resemble "*the shape of a bay-leaf.*" The terms geometrical circles or pitch lines are not understood.

Having taken some care with the curves used in the Clock in question, and believing it may prove advantageous, if the same system be generally adopted in the construction of the teeth of wheels in such machines, I am induced to lay this communication before the British Association.

As the wheels in a Clock move in one direction, an

opportunity is afforded of the teeth being so shaped that the contact, or commencement of the force, may take place at the line of centres, and, if possible, it should not take place before. After cutting many experimental segments of wheels and pinions, adopting various proportions in each case beyond the geometrical circles, I came to the conclusion to use for the wheel-teeth (the driver) the epicycloidal curve, and for the pinion (the driven) the hypocycloidal curve, putting nearly the whole of the curve on the wheel-teeth, increasing the circumference beyond the geometrical circle, by the addition of 3 teeth and spaces, allowing only 0.5 of the pitch of the tooth for the increased circumference of the pinion, just to remove the possibility of any sharp edge. In every case the epicycloidal curve has been described by rolling the semi-diameter of the driven on the geometrical circle of the driver.

It is very necessary that segments of the teeth should be cut for the purpose of ascertaining the breadth, that the wheel-teeth should be in excess above those of the pinion-leaves. For as the breadth of the wheel-teeth is increased, and the leaves of the pinion narrowed, the effect of driving before and after, the line of centres is varied. I have also carried out this theory to the lifting of the hammers for the Bells, both in the Clock and Chime-barrel.

LONDON :

BRADBURY AND EVANS, PRINTERS, WHITEFRIARS.



DENT  
ON  
THE AZIMUTH AND STEERING COMPASS.